5G Rural Integrated Testbed

D2.13 Tourism Use Cases - Interim Final Report

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Table of Contents

1 Executive Summary

Over the last year as part of the Department for Digital, Culture, Media and Sport 5G Testbeds & Trials Programme, the 5GRIT project has brought together various tourism stakeholders and technology service providers in and around the North Pennines region. The interactions among these stakeholders created an opportunity to understand problems within the region and also created possibilities for innovation around enhancing the in-destination experience of tourists in the rural areas to bring in economic & social benefits within the region.

Our main research question was : how does 5G infrastructure enable the development of rural tourism focussed mobile augmented reality applications, which bring economic and social benefits to the region, especially in those areas which lack connectivity?

To answer this question we decided to a) enhance an established AR application called World Around Me (WAM) to deliver video streaming of heritage content over 5G b) create other AR/VR applications to deliver immersive heritage content over 5G and bring the community together. Both approaches were taken to create economic & social benefits within the region.

World Around Me (WAM) augmented reality based mobile app helps travellers find on-demand useful travel information like directions, opening hours, activities, local restaurants, bars & pubs, shops and other places of interest. Using augmented reality WAM helps visitors find a sense of direction. It is the winner of Google Play award 2016 in “Early Adopter” category for its intuitive augmented reality discovery experience. It is also “Editor’s Choice app on Google Play. Over 70,000 users in UK and over 1 million users worldwide search & discovery nearby services using WAM.

5G infrastructure presented a huge opportunity to present network heavy augmented reality based rich immersive audio video content through WAM app to visitors in the AONB region. This content has been curated by NPAONB staff and uploaded to WAM Tourism Platform (CMS) which powers the local discovery experience. We have identified key locations around the North Pennines where 5G network can improve visitor experience. WAM’s AR based local discovery experience is already helping tourists find nearby services and learn about heritage with audio/video story telling.

We have established a direct relationship between WAM usage in the region and its economic and social benefits, which are now being reported on a monthly basis. Over the next 6 months we will be testing WAM usage by tourists over 5G network and will continue to monitor and report its economic and social benefits to the North Pennines region.

We also invested in co-creating other AR/VR applications with the local community to show them the benefits of 5G for their region. These applications will be launched in April 2019. The other AR/VR projects have so far focussed on creating a strong social impact by engaging various community members in these projects. These projects have contributed

towards cohesion and local skill building. Over the next 6 months we aim to explore and report economic and social impact of these other AR/VR projects.

2 Introduction

According to VisitBritain, in 2014, there were 17.08 million trips to the countryside on domestic overnight trips in England, 18% of the total, with spend at £3.1 billion (17% of all spending on domestic overnight trips). There were also 340 million tourism day trips involving a trip to the countryside – or 25% of the total – with associated spending of £8.4 billion (19% of all spending on day visits).

Around 70-80% of tourism day trippers come from within the region they are visiting. This is highest in North East and the North West (85%). Northern Pennines AONB is uniquely positioned across the North East & North West to benefit from this trend.

The North Pennines Area of Outstanding Natural Beauty and UNESCO Global Geopark is a stunning landscape of sweeping moorland views, cascading waterfalls, colourful hay meadows, vibrant communities and spectacular wildlife. Most of North Pennines AONB is rural. Many areas across the region still do not have a phone signal and internet access.

They are keen to explore new ways to reach out to tourists. 5G infrastructure presents an opportunity to channel rich audio and video content about oral histories and stories about mining to the audience.

With the rise in the Digital Revolution - there is also a need to digitally promote the plethora of activities and places in a simple and accessible manner. Communicating digital information about places and rich immersive heritage content requires a high transmission network to enable dissemination of content. 5G presents an opportunity to fill this gap.

World Around Me (WAM) augmented reality based mobile app helps travellers find on-demand useful travel information like directions, opening hours, activities, local restaurants, bars & pubs, shops and other places of interest. Using augmented reality WAM helps visitors find a sense of direction. It is the winner of Google Play award 2016 in “Early Adopter” category for its intuitive augmented reality discovery experience. It is also “Editor’s Choice app on Google Play. Over 70,000 users in UK and over 1 million users worldwide search & discovery nearby services using WAM. 5G infrastructure presented a huge opportunity to present network heave augmented reality based rich immersive audio video content through WAM app to visitors in the AONB region.

During the 5GRIT project, which is one of 6 5G Testbeds & Trials projects funded by the Department for Digital, Culture, Media and Sport, WAM Tourism platform (a web based Content Management System) was enhanced and provided to the North Pennines tourism partnership enabling them to promote local heritage storytelling with audio & video and local events information through World Around Me app in augmented reality. The local events will

include information about things to see and do. This tourism platform will be enhanced to add edit locations and information about local heritage locations. This enhanced tourism content especially video over 5G will be delivered to the tourist through WAM app.

Thanks to the 5GRIT project the North Pennines Area of Outstanding Natural Beauty (AONB) Partnership has created three new digital experiences designed to provide a step change in how tourists interpret their destination.

Designed to immerse visitors in the hidden histories of the North Pennines AONB, it is focusing on Alston as the destination with the most potential for tourism engagement in the area, and using the town as a launch pad to other locations in the North Pennines AONB to spread the benefits of tourist stay and spend.

3 Research Question - what we set out to achieve

Our main research question was : how does 5G infrastructure enable the development of rural tourism focussed mobile augmented reality applications, which bring economic and social benefits to the region, especially in those areas which lack connectivity?

To answer this question we had to answer the following :-

1. Which are the ideal locations within the North Pennines to provide the 5G network access which can improve the visitor experience?
2. Which mobile AR experiences over 5G improve the promotion & discovery of local businesses and audio/video heritage content?
3. How can we measure the local economic impact of the new 5G enabled mobile AR services?
4. How can we measure the local social impact of the new 5G enabled mobile AR services?

NPAONB has local rich heritage documented which if conveyed to visitors can enhance their discovery experience. Lots of this information was stored in old audio guides or mainly with local community historians who have been living in the region for a long time.

Many local businesses in the region thrive with the tourism activity. However when a place has lots to offer, often a lot goes unnoticed or undiscovered by the visitor. Pamphlets, brochures and region's websites are the only way to communicate to visitors about the offering. With the growth of smartphones and change in visitor behaviour towards on demand access to information - the traditional advertising channels are not able to fulfil the on demand needs of visitors.

4 Implementation

The context to answer the above questions was set by developing an understanding of the tourism activity in the few areas within the NPAONB region.

We looked at various user personas of tourists with a view to improve their in-destination experience with 5G enabled augmented reality services, which had to be created during the project.

Keeping these personas in mind we designed 5G enabled AR experiences within the WAM app and AR/VR apps created during the project as explained below.

WAM App enhancement

In earlier project discussions we looked at identified locations around the NPAONB where 5G network could be made available to tourists. This helped in curating heritage audio/video content specifically for these locations, namely Nenthead Mines, Ninebanks & Alston.

The enhancement of WAM app focussed on provisioning WAM Tourism Platform for the NPAONB staff and regional partners and enabling them to promote local events & heritage locations with audio/video storytelling over 5G to users using WAM app in the region.

A geofence was set up around the NPAONB region to show a new section in the WAM app called “Discover North Pennines”. This section has an events category, which enables content discovery about local events through WAM mobile app. It also has a heritage category which enables discovery of local heritage locations in AR along with audio/video oral histories. The content in the “Discover North Pennines” section is powered by WAM Tourism Platform.

The staff at NPAONB were given access to WAM Tourism Platform to add information about various heritage locations in text, images, audio & video format. They curated the audio/video content in partnership with local historians who participated in various audio/video shoots.

During the project NPAONB staff added heritage and events content to the WAM Tourism Platform. This content is now discoverable to tourists using WAM app within the region.

Other AR/VR apps & experiences

The three apps use different types of interaction, one using virtual reality (VR) so visitors can explore a building of great historic interest but with difficult access; a second using augmented reality (AR) actors to bring alive stories from the past; and a third being a community project with the local school that uses digital interactions such a photographic rub-aways, trails and puzzles to reveal the historic features of the local landscape.

The virtual reality cornmill

This virtual reality immersive app experience shows what lies behind the decaying exterior of one of Alston town's most imposing but secretive buildings, the High Mill corn-mill. The building still houses a 30ft waterwheel dating from 1817 but this impressive feature cannot be seen by casual visitors - the app enables them to step inside the mill's wheel-room to witness it in action. The app also hows how the cornmill operated by stripping away the external walls of the building to reveal its life in the past.

The VR experience for mobile phones can be downloaded at www.highmillvr.com - headsets for visitors will be available at Local Links within the Town Hall alongside a display explaining about and the process of creating VR to bring history to life.

'Ghostlines'

This is an augmented reality app experience where the figures of historic characters from the past come to life using their actual words in four locations with which they were associated. Using augmented reality the characters will appear as ghostly, living images on the viewer's phone. In Alston the app will bring to life Joseph Pearson – Alston's postman between 1849 – 1870s standing outside an Alston doorway and remembering events from his diary. His recalls stories of families from the area leaving for Australia and America, local entertainment, local deaths and accidents and the solving of local crimes.

Other characters include Thomas Sopwith, WB Lead's Mine Manager at Allenheads, and Joseph Pearson the local preacher who led the 1849 Miners' Strike; a miner at Nenthead Mine; and Isaac Holden, the itinerant tea-seller who raised funds for the Ninebanks Hearse House.

The Alston School Family Explorer app

The North Pennines AONB Partnership's reappraisal of the initial personas provided by the project showed that there was an opportunity to provide an experience that appealed to family explorers as well as more mature visitors. The AONB Partnership approached Samuel King's School in Alston to see if they would act as partners in this project and was delighted that they accepted, with Mr Fletcher and the Year 6 ICT having the opportunity to be involved in some real life digital design.

The students worked with a 'digital mentor' through the whole design process of app development from personas and identifying local stories right through to logo design. Their stories, puzzles and designs have created an app that will be ready to launch to the community and wider public on Tuesday 16th April.

The trails were developed with a member of Alston Moor Parish Council and historic material was provided by two local historians.

Further details of the building of the three NPAONB apps are can be found in appendix 1.

5 Key Learning Points

WAM

Other than NPAONB, who will be the potential partners to benefit from WAM Tourism platform? Local events & heritage organisations who would like to increase footfalls are potential partners to use the service.

How to sign up tourists to 5G network and use WAM on it? Few regions in the North Pennines have 3G access and many areas have no phone signal at all. We identified a region around Ninebanks where there is no phone signal. We are exploring a potential partnership with a Youth Hostel where we would setup a 5G Wifi network, that hostel visitors could sign up to and then use WAM over it. Usage would help us understand 5G latency for the network setup at the youth hostel.

Too much content makes it challenging to communicate well with tourists. This is a classic information design problem which we solved by simplifying the way tourists will discover content in WAM. We focussed on creating content for those places which bring benefit to the region in terms of money flow and developing a personal relationship between the Pennines.

During a 5G workshop conducted in Penrith we learnt about interest of some regional organisations who wanted to explore ways to encourage tourists to spend more time on the local wifi setup by using WAM.

Other AR/VR applications

The most important learning point is that the need for community involvement. This gives the project relevance in terms of serving community needs: at the school we were able to contribute in a meaningful way to engage students in the process of designing and producing an app, and having their voices recorded as part of bringing the history of their town alive, we were also able to engage with local people in discovering stories about the town that do appear in standard tourism literature.

Local businesses have been involved through the owners of the High Mill giving us access to the building and its archive material and a local shop will provide the doorway in which the augmented reality postman appears - we would certainly anticipate that this would bring some direct benefits to sales.

The students creating the school app were keen that local businesses offer prizes such as cakes as a reward for completing the challenges of the trail - giving us another chance to engage visitors with the businesses of the town.

There is a certain amount of resistance in the town to 5G which was brought into sharp relief after the press call in February publicising part of the project. This was diffused by a presentation to the Parish Council given by representatives of Cybermoor, Quickline and the University of Lancaster but it must be recognised that this is an ongoing concern to local

people and that any publicity must be carefully worded and checked by all participating parties.

Secondly we have discovered that augmented reality gives a greater degree of immersion and engagement than possible with non-AR apps. As AR offers the opportunity to explore new avenues of story-telling and information sharing the decision was taken to design an app that used a trail to encourage tourists to visit further destinations.

Thirdly it is clear that to properly monitor and evaluate this project it needs to be delivered during the tourist season. For the North Pennines, as a remote and still under-visited area, this is heavily weather dependent so tends to run from Easter until the end of September. We are grateful for the extension that will enable us to record the results of these new tourism products.

6 Results

WAM

On 12th Nov 2018 we launched an update of WAM iOS app to iTunes app store with "Discover North Pennines" section powered by WAM Tourism Platform (CMS). CMS includes a fully functional heritage content management system with audio and video uploading capability. This was tested over the 5G network. The "Discover North Pennines" section in WAM app is enabled by a geofence around the North Pennines regions, so it is only visible to those tourists who are within the geofenced region.

Between 12th Nov 2018 & 31st March 2019 we have been measuring the Economic impact of the WAM application in the region. The economic impact is calculated the number of WAM searches in the region. Each search resembles the intent of a user to search for services like restaurants, cafes, events, atms, heritage places etc. We have taken a conservative value for each WAM search as of £10. From 12th Nov 2018 till 31st March 2019, 727 WAM searches happened in the region, creating a local economic benefit of £7,270.

On 28th Nov 2018, in Penrith, a workshop to engage with cumbrian businesses was organised by 5GRIT. During the workshop WAM on iOS with the "Discover North Pennines" section was shown to the audience. They were shown how heritage locations could be discovered using the WAM app and how tourists could engage with oral histories in audio / video format. We shared with the audience details about the 5G use case and how local businesses and activities could be promoted using WAM.

Since Penrith was within the geofence of the Discover North Pennines section was visible to all iPhone users who downloaded WAM.

Attendees who represented local authorities were impressed by the usability and various search possibilities with WAM. They asked about the specifics of how long it would take to setup WAM Tourism platform for their specific region. They found the camera discovery

feature very intuitive.

Others were looking at ways to encourage tourists to spend more time on the local wifi setup by using WAM, since people spend a lot more time while searching on the camera as opposed to searching on a map. This is because while searching on the camera, people learn more about their surroundings since information on WAM is overlaid on the real world.

Other participants were surprised to find how local services like a “chip shop” or “chippy” could be found on WAM, including information about their opening hours and location. They liked that WAM could serve both as a local search engine and also help people find information which even Google doesn’t provide.

On 28th Jan 2019 a workshop was organised for local tourism businesses to train them to use WAM Tourism platform so they can add information about local events and more heritage locations with audio/video content. Also they were trained to create / update their “Google My Business profile” so they are easily discoverable by tourists using WAM. We received a good attendance from local businesses including Harbut Law Cottages, Ryder House BnB, The Top Cafe, Alston Wholefoods, Nenthead Arts & Visitor Center and Sunrise Cottage Nenthead. The theme of the workshop was to give businesses an overview of the WAM app, WAM Tourism Platform to add events and heritage content (audio/video) and Google My Business profile management for local businesses.

The session started with a demonstration of WAM app to find local cafes and search for local businesses like Whole foods cafe. The visual orientation capability appealed to the local businesses and all of them downloaded WAM on their devices to have a go at it. They found it intuitive and were keen to explore how their businesses could be discovered on WAM.

This was followed by a demo of the web CMS highlighting the Heritage content already added by NPAONB Partnership. There were no live events on the system, but businesses who organise events were keen to add them. The businesses were interested in using the Events capability to draw visitor footfalls to their businesses. Harbut Law Cottages suggested they will mention WAM Events capability to a friend who runs a Golf course which organises events throughout the year. Nenthead Arts & Visitor Centre were keen to add their events on WAM. They have been given access to the system along with Gina Perryman from The Top Cafe. They found the system intuitive and user friendly.

We checked that not all information about Harbut Law Cottages & Sunrise Cottage was showing up on WAM - so we conducted a one to one session with these businesses to update their Google My Business profiles. This was done to ensure that correct information about them appears to WAM users in the region.

WAM promo leaflets were shared with all the attendees who will be sharing those with their customers and encouraging them to use WAM in the region.

During the session we launched a new promo video about engaging with local heritage content (audio/video) in the North Pennines was shown to all the attendees. Madeleine Parvyn from Alston Wholefoods really liked the video and offered to share it with their subscribers on their website, email and social media.

The local businesses see the benefit of being discoverable on WAM, so in the coming weeks we will be focussing on increasing WAM adoption in the region through the workshop attendees, their customers, partners and also various PR channels.

Between Jan & March 2019 we identified & established a partnership for setting up a 5G hotspot to conduct controlled user trials with WAM usage, especially to measure latency with video streaming. The location of the Youth Hostel in Ninebanks in a region within NPAONB with no network coverage whatsoever. There is no phone network at all and some local buildings have a very low speed wifi network. Some of the heritage locations with audio/video content are located around this region, which is walkable.

About 250 WAM promo leaflets were given for distribution at YHA Ninebanks, Local visitor information centre, local B&B's, local cafes to promote WAM to their tourists.

Other AR/VR applications

The main result of the building of the three apps is a community engagement with the town, its community bodies and businesses. We present details of how various community members were engaged in this project.

The main result of the building of the three apps is a community engagement with the town, its community bodies and businesses. The main contacts, with their activities relating to this project, are listed below:

Alix Martin – Chair: Alston Moor Parish Council

The Parish Council provided the forum in which to present the three planned apps to the local community to pick up on any areas of concern. At the time of the first presentation there was interest but no real concern and the presentation lead to a useful partnership with one of the councillors, Maxine Shepherd, who provided useful guidance - described below.

Maxine Shepherd (Nenthead Chapel) – Alston Moor Parish Council

Maxine proved to be a very helpful conduit into the community and town of Alston as she knew its geography and issues. She was particularly helpful in designing the second trail for the schools app which takes visitors around the outer edge of the town

Simon Danby – Alston Historical Society

Simon was an invaluable contact in providing archive films and photographs that could be used in the school app and in sharing his knowledge about the recent history of the town. His archive photographs will enable us to provide digital 'rubaways' where a contemporary

view of the town is rubbed away on screen to reveal an archive picture of life in the past below,

Alastair Robertson – Alston Historical Society

Alastair provided an important resource in the diaries of Joseph Pearson, Alston's postman between 1847 - 68, a subject of one of the augmented reality historic reconstructions. He also provided information through the Historical Society website which greatly helped with the stories of the workhouse and police station.

Ian Johnson – Headteacher, Samuel King's School

We are grateful to the Headteacher of Samuel King's School in allowing us to lead the Year 6 ICT clas through the process of designing and creating a mobile phone app.

Mark Fletcher – ICT teacher, Samuel King's School

Mark, who allowed this project to work closely with his Year 6 ICT class, has been a great enabler of seeing the potential of an app in sharing the story of his town with visitors

Year 6 ICT – Samuel King's School

These are the 11/12 year old students who totally engaged with this project and taught us as much as we taught them. Their voices appear on the audio clips that guide tell visitors the stories of different locations in the town.

Ian Grey – owner of the High Mill

Ian runs a local business and has recently bought the High Mill and is looking for ways to develop it. He gave us access to the mill, its archive and recent architectural surveys that greatly sped up the process and ensured the accuracy of the eventual project.

Sally Hemsley – Eden Council

The High Mill VR will be the subject of a small display in Alston Tourist Information Centre and four VR headsets will also be available here for tourists to enjoy.

Natasha Richardson – Blueberry's cafe

Natasha supplied us with a host of local stories, some of which were included in the Schools app

Amanda Kidd – Market Cross, Alston shop

Amanda is kindly allowing us to use the doorway next to her shop as the site for Joseph Pearson, one of the AR historical characters. She is supportive of this venture as she thinks that it will be good for local business.

Jenny Snowden – Quickline/ Pennine Ways Alston

Jenny and Quickline have supported us in providing booster equipment to Nenthead Mines and the Ninebanks Youth Hostel.

Pete Jackson – Nenthead Mines Conservation Society

The Nenthead Mines Conservation Society has given us access to film underground to share the experience of the normally inaccessible parts of the mine with a wider audience. A

selection of these films are available via the WAM app and the whole suite will be available through an interactive map information panel with RFID/NFC triggers later in the year. These films are enabled by a booster installed on the site by Quickline as part of this project.

Gina Perryman – Top Cafe

The Year 6 ICT students are keen that prizes are given to visitors who successfully complete the trail challenges. Gina has offered that her cafe could offer prizes and we anticipate that once one local business is taking part others will follow.

Ken and his staff – Angel Inn

A ghost story related to us by staff within the Angel Inn forms the subject of a short film and narrative that will appear on the school app. We are grateful to Ken - the manager of the Angel - and his staff for giving us access to film this story over a busy lunchtime.

Ian and Pauline – Ninebanks YHA

Ian and Pauline manage the Youth Hostel at Ninebanks and as well as hosting one of Quickline's boosters are allowing the hostel to be one of the sites on the augmented reality Ghostlines trail.

Colin McKeighly – Nenthead Mines volunteer

Colin - a volunteer at Nenthead Mines - also is one of the actors on the augmented reality trail. By involving local people at all stages in the process we hope that take up of the various digital experiences will gain local traction through 'word of mouth'.

Ian Forbes – Local historian

Ian is a major local contact for historical stories about the town having published a series of books on the town's history. His support in wanting to make history engaging will help us bring local support of a more traditional audience to the use of the apps.

Roger Morris – Local historian

Roger was the driving force behind Isaac's Tea Trail - a local long distance walk - his support of including Isaac Holden with the augmented reality app will help drive its appeal to the walking/ rambling audience.

Nic Cullens – South Tynedale Railway

We intend to create a further trail for the school app over the early summer that will start at Alston station. We anticipate filming local volunteers and the steam engines, both in the repair shed and on the track, to add to the appeal of this important visitor destination.

7 Future Work

WAM

The YHA Ninebanks hostel hosts tourists all year round. Its location is rich in geology and history, especially because of its proximity with Isaac's tea trail. 5G boosted wifi infrastructure will be setup during April 2019, enabling tourists to connect to Wifi and use WAM.
We will increase the adoption of WAM app at the sites which have no other network but the 5G powered wifi. We are in discussions with local regional businesses for both setup and app promotion.

Instrumentation for testing the 5G network latency has been setup in WAM app already. Once the 5G network infrastructure is available for connection to tourists in the region, then we will be able to monitor the network latency for video streaming over WAM and also bring in the performance improvements into the mobile & web applications.

Presently some of the app usage is over 5G powered wifi signals and the rest is over the existing 5G. We will be working closely with the partners to distinguish between the various networks and bring that into our reporting.

Other AR/VR applications.

A launch of the three digital experiences developed by the North Pennines AONB Partnership will be held in Alston on 16th April.

The three apps will be using Google analytics to harness visitor data. The apps will be launched in early April to coincide with the start of the tourist visitor season at Easter and will be reported on a monthly basis.

As community engagement lies at the core of this project we will be giving free cardboard VR sets to the community so that they can enjoy and share the VR cornmill in the comfort of their own homes.

The school app - particularly the sound recordings and film produced with the children - will be shared at a family parent evening. It is hoped that this will harness interest within the community which will then spread wider.

The tangible measurable results will be through businesses in the town and the AONB Partnership will liaise with the local business association AMBA (Alston Moor Business Association) to measure if there is any increase on like-for-like trade with last year (Easter to end September 2018).

8 Conclusions

Over the last year, the 5GRIT project has brought together various tourism stakeholders and technology service providers in and around the North Pennines region. The interactions among these stakeholders created an opportunity to understand problems within the region

and also created possibilities for innovation around enhancing the in-destination experience of tourists in the rural areas to bring in economic & social benefits within the region.

From WAM perspective we have identified key locations around the North Pennines where 5G network can improve visitor experience. WAM's AR based local discovery experience is already helping tourists find nearby services and learn about heritage with audio/video story telling. We have established a direct relationship between WAM usage in the region and its economic and social benefits.

Over the next 6 months we will be testing WAM usage by tourists over 5G network and will continue to monitor and report its economic and social benefits to the North Pennines region.

The other AR/VR projects have so far focussed on creating a strong social impact by engaging various community members in these projects. These projects have contributed towards cohesion and local skill building. Over the next 6 months we aim to explore and report economic and social impact of these other AR/VR projects.

Appendix 1 Building of the AR and VR apps

1. The VR Cornmill

The tour was built by local (Hexham based) digital 3D designer Simon Edwards of 3Dartvision.

Simon began by researching using all the available visual references that featured this mill and others of a similar date. The owner of the mill, Ian Grey of Acumen Ltd in Alston, and Crosby Granger, his architects were particularly helpful in providing drawings, documents, maps, photographs and anecdotes, plus recent surveying information.

On visiting the building with the North Pennines AONB measurements were made using a laser measure and a full photographic record of the building was taken.

As the building no longer contains any machinery, besides the 1817 water wheel, comparative analysis was made at the Heatherslaw working mill in North Northumberland to understand how a water driven corn mill such as this would have been internally organised and how it may have functioned.

This working mill was built in 1768 and extended in 1830, built at more or less exactly the same period as High Mill.

Sound recordings were taken here to be used in the VR tour. With all this knowledge it was possible to make an informed interpretation of how High Mill would have been originally structured, how the spaces would have been organised and how the mill may have functioned.

Using a ‘Gear360’ camera which takes photographs using a 360° lens photographs were taken of the mill for the opening scene for the mill on the tour.

Using this ‘panoramic’ photograph as a three dimensional digital space using a ‘virtual’ 360° lensed camera was created inside the computer.

Three dimensional modelling was built using an assortment of software including: 3dmax Design, Zbrush, Marvelous Designer and Vray.

The scenes (once built) were exported as colour renderings in a ‘stereoscopic’ format. This means that each scene is rendered twice (one image for each eye). Each image is offset slightly such that when viewed together they produce the additional effect of a greater depth to the scenes. This can be seen most clearly in the 1850s scene where the sparrow and metal railings in the foreground clearly appear to be much closer than the buildings behind.

Animation in the water wheel scene and the creation of the water flow was achieved by adding a rotational movement to the model of the wheel over a four second time frame. This was then later scripted to loop continuously in the VR tour.

The water in this loop was created using physical simulation software. Once adding a downward gravity force inside the scene, a source of particles (which were setup to physically behave as water) was spilt out onto the rotating wheel. These particles were then converted into a physical mesh which had a transparent and reflective material applied to it.

The scenes where then organised into a VR tour using xml and html scripting. Each image is split down into a smaller mosaic (using software named 'krpano') in order to 'dynamically' load faster from the web. Buttons and rollover texts, built in both 3d and 2d graphic programmes, were scripted into the scenes and the two short animated movie sequences seen in the library scene were written, narrated and put together using 'After Effects'. All the remaining sounds were sourced and scripted into the tour. Additional scripting was written to provide the directional sound effects heard in the tour and to create the light flare beaming off the top window in the 1850s scene.

This experience relying on real-time streaming of heavy video and audio content will test the capacity of the 5G infrastructure provided by Cybermoor/ Quickline to provide fast download.

2. Ghostlines

Scripts were written in conjunction with local historical experts, accents were recorded from local people so that the actors who played them on the app would have authenticity.

The app was designed so that visitors can see the character through their phone's camera against the contemporary scene. This required creating films with a transparent alpha channel so that the figure appears in ghostly isolation.

Pollen Studios in Yorkshire were selected to film the characters as we required a green screen studio to achieve this.

Five actors were selected, briefed with the scripts and sent recordings of the relevant accents.

Filming was completed in the green screen studio in February and the films uploaded to the app design company.

The files will be triggered by image recognition as the viewer needs to stand far enough away from the trigger point to get a full figure standing in their phone screen.

These visual triggers are a victorian doorway next to the Market Cross Alston shop in Alston; the entrance to Smallcleugh mine at the Nenthead Mines; the YHA sign on the garage door at Ninebanks Youth Hostel; and the steps in the Blacksmith's shop in Allenheads.

This app will test the 5G capability of the infrastructure put in place by Cybermoor/ Quickline as the file sizes of the films are around 170mb each.

Satellite Navigation

We have used Global Navigation Satellite System (GNSS) data to plot the four visitor attractions on custom maps in *Ghostline* and create driving routes between the four sites. This makes it easy for visitors to move between locations.

We have also used the GPS receiver, located in mobile phones, to trigger the presentation of content that is relevant to the physical location of the user. This is achieved by attaching GPS coordinates to different content elements in the app and programming them to 'display' on the user's phone when these GPS coordinates are matched by the physical location of the user. Their location is determined by the GPS receiver in their phone.

Augmented Reality

We used augmented reality technology to present the illusion that a character from the past has appeared in the form of a ghost in front of the user to deliver their story.

This is achieved by using the inbuilt camera in the mobile phone to identify a pre-designed AR image marker. When this marker is recognised the film of the character is programmed to play. The film is produced with a translucent background, so it appears as if the figure is standing in the physical environment occupied by the user.

This is a new area of work for many, and it was only through the close collaboration between the Flo-culture tech team and Pollen, the film production company, that this was achieved.

Overall the AR interface delivers a more personalised experience for the user and provides an engaging format through which to provide historical information.

3. The Alston School Family Explorer App

The trails for school app were developed with a member of Alston Moor Parish Council and historic material was provided by two local historians, Alastair Robertson of Alston Historical Society and Simon Danby, of the same society who has an archive of historic photographs of the town curated over two decades.

The students were keen that the trail should be gamified so it is full of puzzles and clues. The resulting app provides location-triggered visitor trails around Alston; one around the centre of town and a second including ghost stories followed on a self-guided trail around the outside of the town. The trails include historic stories, quizzes, films and audio.

The class has been taken the whole process of designing a mobile phone app for visitors from working out who would find the app useful, to designing characters, challenges and icons, to having their voices recorded telling some of the history and stories of the town.

One story 'The Girl in the White Dress', narrated to the NPAONB in a local cafe, features on the app as a short film starring one of the students. Another telling the ghostly story of the Angel Inn is also featured as a film. These films were produced by Middlesbrough film company Ithica films.

Their stories, puzzles and designs have created an app that will be ready to launch to the community and wider public on Tuesday 16th April.

This app is also built by Flo-culture using the same methodology as for 'Ghostlines'.